

US-JAPAN COOPERATIVE RESEARCH IN URBAN EARTHQUAKE DISASTER MITIGATION

A US-JAPAN COMMON AGENDA PROGRAM

IN COLLABORATION WITH U.S. NATIONAL
EARTHQUAKE HAZARD REDUCTION
PROGRAM (NEHRP) AGENCIES

Joint Program Announcement By

Earthquake Hazard Mitigation Program
Hazard Reduction Cluster
Division of Civil and Mechanical Systems
Directorate for Engineering
and
Division of International Programs
Directorate for Social, Behavioral and Economic Sciences

DEADLINE FOR RECEIPT OF PROPOSAL

First Year Deadline: *March 15, 1998*
Subsequent Deadlines: *October 1, 1998*
October 1, 1999
October 1, 2000
October 1, 2001



NATIONAL SCIENCE FOUNDATION

US-JAPAN COOPERATIVE RESEARCH IN URBAN EARTHQUAKE DISASTER MITIGATION

Division of Civil and Mechanical Systems and Division of International Programs

INTRODUCTION

Earthquake engineering and hazard mitigation research has resulted in a significant expansion of fundamental knowledge in the behavior of structural and geotechnical systems during earthquakes, their engineering design, retrofit, and strengthening for increased safety, and the socioeconomic impacts, consequences, and countermeasures of damaging events. At the same time, seismic hazard mitigation problems have become increasingly difficult. For example, our built environment - buildings and civil infrastructure systems and networks - are increasingly complex, and the requirements for their performance and safety are also increasingly high. Furthermore, the inherent social and engineering contexts of these infrastructure and urban systems - as exposed by many surprises and new discoveries during recent damaging events such as Loma Prieta (1989), Northridge (1994) and Kobe (1995) - indicate strongly that new and bold approaches to mitigation are required. Over the years, the Earthquake Hazard Mitigation (EHM) Program in NSF's Hazard Reduction Cluster (HR) has supported interdisciplinary efforts to advance knowledge related to earthquake engineering and hazard mitigation, and has enabled the transfer and application of the new knowledge through a well balanced program consisting of individual investigator research projects, coordinated research projects, small group research and center research. EHM/HR is an NSF program which supports the nation's earthquake engineering and related research and education under the guidance of the NSF strategic plan. EHM/HR also plays an integral part in the National Earthquake Hazards Reduction Program (NEHRP)* that Congress established in 1977 to mitigate the nation's earthquake hazards through coordinated efforts in research, mitigation, and related activities among federal agencies.

Both the United States and Japan are making significant investments in earthquake engineering and hazard mitigation research. Natural and Man-Made Disaster Reduction has been added as an initiative under the US- Japan Common Agenda for Cooperation in Global Perspective, a program established by the President of the United States and the Prime Minister of Japan in 1993 to facilitate cooperation between our two countries in addressing a broad range of the world's most pressing problems. Three joint US-Japan workshops—in Maui in December 1995, in Osaka in January 1996, and in Tokyo in February 1997 - were convened for the purpose of developing a joint US-Japan re-

search program by examining the opportunities and prioritizing the intellectual challenges.

Details of the workshops' recommendations are contained in the reports published respectively for (1) the 1995 Maui meeting by University of California, Berkeley entitled "US-Japan Workshop on Cooperative Research For Mitigation of Urban Disasters: Learning From Kobe and Northridge —Recommendations and Resolutions," edited by Steve Mahin, Earthquake Engineering Research Center, Report No. UCB/EERC-97/03, (2) the 1996 Osaka meeting by University of Southern California entitled "North America-Japan Workshop on the Geotechnical Aspects of the Kobe, Loma Prieta and Northridge Earthquakes," edited by J.P. Bardet, Ed Idriss and Thomas O'Rourke¹, and (3) the 1997 Tokyo meeting by University of Southern California entitled "The Second US-Japan Workshop on Cooperative Research For Mitigation of Urban Earthquake Disasters,"² edited by M. Shinozuka, Department of Civil Engineering, University of Southern California.

NSF and Japanese agencies will commission expert national committees to coordinate US-Japan joint research activities related to mitigation of urban earthquake hazards. The U.S. committee will draw its membership from the research community and will provide the following services: (1) offer technical guidance for the initiative, including recommendations related to program evaluation of this initiative; (2) organize and schedule activities such as domestic and bilateral technical coordination meetings among active principal investigators and invited experts and consultants; (3) facilitate exchange of research data, information, and personnel - including students - domestically as well as across the Pacific Ocean; (4) assist in the development of partnerships, where feasible, with industrial companies in both the United States and Japan; and (5) facilitate the transfer and utilization of knowledge and technology resulting from the joint research.

With this announcement, NSF initiates a new competition of research proposals related to the mitigation of urban earthquake hazards to be funded through the Division of Civil and Mechanical Systems in the Directorate for Engineering and the Division of International Programs in the Directorate for Social, Behavioral and Economic Sciences. Counterpart activities by Japanese researchers will be funded by the Japanese Ministry of Education, Science, Sports and Culture and other relevant Japanese ministries and agencies. This announcement describes the purpose, objectives, special features, and application procedure and review process of the U.S. side effort on new integrated research

*The principal NEHRP agencies are: Federal Emergency Management Agency (FEMA), National Science Foundation (NSF), U.S. Geological Survey (USGS), and National Institute of Standards and Technology (NIST).

¹ <http://rccg01.usc.edu/GEES/Reports/Report2.html>

² <http://www-rcf.usc.edu/~shino/>

for the mitigation of urban earthquake disasters. Individual projects and small group projects of interdisciplinary study involving advanced industrial technology as well as innovative approaches are encouraged.

DESCRIPTION

The purpose of this initiative is to foster, in cooperation with Japan, interdisciplinary research for mitigation of urban earthquake disasters. The research will involve structural, geotechnical and social systems and their interface and integration. The research initiative will focus a concerted effort in several high-priority areas—most are cross-cutting—that are considered pressing and which are suitable for US-Japan cooperation. These cross-cutting areas include but are not limited to:

- The geological process of shallow crustal earthquakes, their near field ground motions and the structural and geotechnical effects of the ground motion.
- The impacts of damaging earthquakes on urban areas as a whole, including life safety, damage costs, economic productivity, earthquake caused fires, and environmental emergencies.
- The socioeconomic, cultural and political processes that affect the vulnerability of urban areas and constrain mitigation efforts.
- Innovative methods and new technologies for mitigation, protection and repair, and for systematic recovery and reconstruction.
- The development and applications of new technologies and materials to the problems of steel-frame structures made evident by the Northridge and Hanshin (Kobe) earthquakes.
- Research on performance-based engineering methods and standards, that is, the design of structures to meet a specified level of successful performance during strong earthquakes.
- Research that involves advanced technologies and materials, such as robotics, smart structures, geographical information system (GIS) and global position system (GPS), etc.
- More accurate and robust hazard and vulnerability assessments, and integrated methods for assessing costs and loss and making strategic decisions.

On the basis of the above areas, research proposals are solicited in the following areas:

(1) Performance-based Design and Engineering

New approaches are needed to mitigate the enormous economic losses in commercial activity and industrial productivity associated with damage to lifelines and infrastructure systems. Engineering techniques must be developed for selection of per-

formance objectives taking account of risk and loss, and new tools must be sought to allow design options in which multiple performance objectives can be met for both new designs and rehabilitation. Below is a partial list of the research in this area that is needed to expand the technical/engineering/scientific knowledge base for performance-based design and engineering:

- Engineering definition of performance objectives (expected levels of response/damage) and seismic hazards.
- Characterization of structural, non-structural, and lifeline response and of seismic input.
- Widely applicable means to assess response/damage in terms of performance objectives.
- Development of performance-based engineering procedures.
- Social aspects, legal consequences, and acceptance of implementing performance-based procedures.

(2) Integrated Social Science and Related Multidisciplinary Research

Significant issues and challenges exist for new research concerning disaster mitigation, preparedness, response and recovery. Hazard mitigation can make communities less vulnerable to damage and other losses through, for example, improved design codes, engineering practices, land use planning, and effective disaster response plans (including organized capacity to carry out those plans). Research on the interaction between physical systems and social/economic systems is important to lessen societal exposure to earthquake risks. Some key problems in this area include:

- Processes affecting pre-event preparation by the public and by organizations.
- Policy and program assessment concerning pre-event recovery planning, reconstruction, land use, and environmental impacts.
- Immediate post-event damage and loss estimation.
- Post-event organized response and coordination, decision-making and resource
- allocation for tasks such as providing emergency shelter, water and medical supplies, public health and sanitation, and housing replacement.
- Development, transferability, and acceptance of loss-reduction policy strategies.
- Research on “real costs” of disasters to communities and broad regions, including recovery financing.
- Integration of structural damage projection models and economic loss models, and assessment of economic costs and benefits for various mitigation measures and strategies.

- Mitigation decision models at different levels and sectors, and adoption and implementation of those mitigation strategies.
- Social acceptability of risk for different levels of performance-based design.

(3) Advanced Steel Structures

One of the major surprises of the Northridge and Kobe earthquakes was the serious damage to steel buildings, especially to welded moment-resisting frames. Technically sound and innovative design and construction methods for new steel buildings need to be developed, and cost-effective and reliable techniques to rehabilitate the existing buildings that are seismically vulnerable are required. Collaborative research efforts that will reduce the future hazards to steel buildings include:

- Effects of welding process and metallurgy on joint behavior, and new approaches to controlling fracture and plasticity under different ranges of temperatures, strain rates, loading histories, and restraint conditions.
- Advanced nondestructive techniques and procedures for construction quality control and condition/health diagnosis, damage detection and repair.
- Advanced high-performance, high-weldability materials and welding procedures.
- Improved structural details including use of innovative energy-dissipative connections.
- Improved structural system concepts for increased deformation capacity to enable, for example, shear yielding in members and connections, and use of bracing and energy dissipating devices and components.
- Proof-of-concept investigations incorporating simulation and large-scale tests.

(4) Geotechnical Engineering Systems

Major surprises—some of them contradicting conventional understanding and probably responsible for some serious damages—were discovered in the Kobe and Northridge

earthquakes. It appears that the source processes that influence near-fault ground motions, and the characteristics of near-fault ground motions, are not well understood. The adequacy of current design methods and standards accounting for near-field ground motions is in doubt. The effects of such motions (e.g., potential for and distribution of liquefaction within urban areas, local modifications of ground motion, and physical nature that governs the performance) require a fresh and innovative look into the engineering and physical nature that governs the performance of geotechnical systems. Some related research topics are:

- Near field ground motions, including site effects—controlling source processes, engineering characteristics, and data base.
- Effects of bedrock topography on ground motions, including basin edge effects.

- Soil-pile and structure interaction.
- Performance of remediated sites.
- Liquefaction, lateral spread, and flow slides associated with strong shaking due to a near source earthquake.

(5) Advanced Technologies

Beyond the conventional approaches to earthquake disaster mitigation, new strategies must be developed by utilizing advanced technologies such as those related to the use of GPS, remote sensing, innovative sensors and sensor systems, real-time information systems, intelligent materials and structures, etc. These advanced technologies can enhance the possibility of more effective mitigation procedures and strategies. Some of these technologies which overarch the major components of the initiative as described above include:

- Innovative engineering materials and devices, including adaptive media materials that respond intelligently to external stimuli for the control and protection of buildings and civil infrastructure systems.
- Prototyping of smart devices, components and structures, and proof-of-concept experiments.
- Advanced protective systems and their deployment.
- New materials and technologies for fire prevention, detection, suppression, control and rapid extinguishing.
- Advanced NDE techniques, sensors and robots for condition assessment and damage detection and control.
- Intelligent robotics and machines for rapid research and rescue, efficient and safe structural demolition, and materials handling and reconstruction.
- Integrated monitoring and disaster information systems and their use for decision making in various mitigation measures.
- Global satellite position systems (GPS) and their use in monitoring of ground and structural motions, as well as of real-time damage/loss assessment and emergency management activities.

This list of research topics and areas is not meant to be all-inclusive or to limit the scope and creativity of worthy research. Research in other areas not covered above, which would advance the knowledge for mitigation of urban earthquakes, is also encouraged.

PROGRAM EXPECTATIONS AND AWARDS

It is expected that projects supported under this NSF initiative will involve significant collaboration with Japanese researchers, including the sharing of ideas, data, equipment and personnel. The intent is to foster synergistic interactions that will advance the research beyond what either side might accomplish separately. Proposals should list, if possible, specific counterpart investigators in Japan and highlight the collaborative aspects of the research plan. Mechanisms will be developed however,

through the technical coordination committee to be created for the initiative, to assist the development of linkages and contacts with potential counterpart Japanese researchers for those proposers who do not have such connections. Active participation of practicing engineers and industrial experts in all phases of the research work is encouraged.

Projects which involve students and researchers in the early stages of their careers will be given priority consideration, and applicants are encouraged to describe how their proposed US-Japan research collaboration might utilize existing programs managed by NSF's Division of International Programs to support research stays by American graduate students and postdoctoral researchers in Japan (see the International section of the NSF homepage at www.nsf.gov or the NSF Tokyo homepage at www.twics.com/~nsftokyo/home.html). Linkages to the "Summer Programs in Japan and Korea," NSF 96-151, and the Japan Society for the Promotion of Science and Science and Technology Agency fellowships are particularly encouraged.

NSF is prepared to invest \$1.5 million per year over a period of 5 years, starting in fiscal year 1998. However, funding will be contingent upon the quality of the proposals received and the availability of funds. About 10 to 15 grants are expected to be made each year, including multiple year projects. In addition to core research funding, NSF will facilitate and support the visits of American researchers to Japan through its various programs for seminars, short-term and long-term international visits, research fellowships, and summer programs for graduate students. These international components could be supported independently, or treated as a supplement to, or as an integral part of, a funded project.

NSF provides support only to the U.S. investigators in the joint projects. The Japanese counterpart investigators involved must obtain their support from their own sources, such as the Japanese Ministry of Education, Science, Sports and Culture.

Principal investigators are expected to send results of their hazard research to NSF-supported information clearinghouses in order to enhance its availability to and utilization by other researchers and practitioners. Computer software programs should be sent to the University of California branch of the National Information Service for Earthquake Engineering (NISEE). Copies of research reports should be sent to the NISEE branches at Berkeley and the California Institute of Technology in Pasadena, to the Information Service at the National Center for Earthquake Engineering Research at SUNY-Buffalo, and to the Natural Hazards Information Center at the University of Colorado at Boulder.

WHO MAY SUBMIT

Consistent with the requirements summarized in Chapter 1 of GPG, "Grant Proposal Guide," NSF 98-2, proposals prepared in response to this Program Announcement must be submitted by a U.S. institution or organization. Multi-institutional proposals are acceptable.

WHEN TO SUBMIT

Proposals for the initial cycle of this initiative must be received by NSF before the close of business on March 15, 1998. Initial awards are expected to be made in fiscal year 1998. For the subsequent years, proposals must be received before the close of business on October 1 for each year from 1998 to 2001, and the corresponding awards will be made in fiscal years 1999, 2000, 2001, and 2002.

PREPARATION AND SUBMISSION OF PROPOSALS

Proposals should refer to this Announcement and should be prepared and submitted in accordance with the guidelines set forth in the "Grant Proposal Guide," NSF 98-2, available via the NSF homepage (www.nsf.gov), or upon request from the Forms and Publication Unit (phone: 703-306-1130, e-mail: pubs@nsf.gov). Application via Fast-Lane (see www.fastlane.nsf.gov) is encouraged.

The "Project Description" section of the proposal should include a rationale for collaboration with Japanese counterparts, including a description of the benefits to be derived from the interactions.

"Biographical Sketches" should be included for each Japanese senior investigator identified as a collaborator.

Support for core research activities under this initiative is consistent with that normally offered by the Earthquake Hazard Mitigation Program, Hazard Reduction Cluster. In addition, the proposal budget may appropriately include funds to support American investigators for US-Japan collaborative activities. The program announcement, "International Opportunities for Scientists and Engineers," NSF 96-14, (available via the NSF homepage at www.nsf.gov or the NSF Tokyo homepage at www.twics.com/~nsftokyo/home.html) provides information on allowable budget items.

INQUIRIES

For program inquiries, contact one of the following staff members at the following location:

(1) Earthquake Hazard Mitigation Program
Hazard Reduction Cluster
Room 545
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
Telephone: 703/306-1361

Dr. S.C. Liu
e-mail: sliu@nsf.gov
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Dr. Cliff Astill
e-mail: castill@nsf.gov
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Dr. William Anderson
e-mail: wanderso@nsf.gov

(2) Division of International Programs
Room 935
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
Telephone: 703/306-1701

Dr. Larry Weber
e-mail: lweber@nsf.gov

EVALUATION OF PROPOSALS

The evaluation of proposals will be based on principles discussed in GPG, "Grant Proposal Guide," NSF 98-2. Proposals will be evaluated by merit review, which may include individual and panel reviews, site visits and NSF management reviews. The two standard review criteria are:

(1) What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

(2) What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning?

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

In addition to the standard review criteria, NSF will give consideration to:

- (1) The potential of the proposed activity to foster US-Japan synergistic interactions that will advance the research beyond what either side might accomplish separately; and
- (2) the planned involvement of American students and researchers in the early stages of their careers.

GRANT ADMINISTRATION

Awards made as a result of this document are administered in accordance with the terms and conditions of NSF GC-1, "Grant General Conditions," FDP-III, "Federal Demonstration Partnership General Terms and Conditions," depending on the grantee organization. Copies of these documents are available at no cost from the NSF Forms and Publications Unit (phone: 703-306-1130, e-mail: pubs@nsf.gov). More comprehensive information is contained in the NSF Grant Policy Manual (NSF 95-26), for sale through the Superintendent of Documents, Government Printing Office, Washington, DC 20402. The telephone number at GPO is 202-783-3238 for subscription information.

The Foundation provides awards for research and education in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the results for publication. The Foundation, therefore, does not assume responsibility for the research findings or their interpretation.

The Foundation welcomes proposals from all qualified scientists and engineers and strongly encourages women, minorities, and persons with disabilities to compete fully in any of the research and education related programs described here. In accordance with federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving financial assistance from the National Science Foundation.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF projects. See the program announcement or contact the program coordinator at (703) 306-1636.

Privacy Act. The information requested on proposal forms is solicited under the authority of the National Science Foundation Act of 1950, as amended. It will be used in connection with the selection of qualified proposals and may be disclosed to qualified reviewers and staff assistants as part of the review process; to applicant institutions/grantees; to provide or obtain data regarding the application review process, award decisions, or the administration of awards; to government contractors, experts, volunteers, and researchers as necessary to complete assigned work; and to other government agencies in order to coordinate programs. See Systems of Records, NSF 50, Principal Investigators/Proposal File and Associated Records, and NSF-51, 60 Federal Register 4449 (January 23, 1995). Reviewer/Proposal File and Associated Records, 59 Federal Register 8031 (February 17, 1994).

Public Burden. Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of your receiving an award.

The public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Gail A. McHenry, Reports Clearance Officer, Information Dissemination Branch, National Science Foundation, 4201 Wilson Boulevard, Suite 245, Arlington, VA 22230.

The National Science Foundation has TDD (Telephonic Device for the Deaf) capability, which enables individuals with hearing impairment to communicate with the Foundation about NSF programs, employment, or general information. To access NSF TDD, dial (703) 306-0090; for FIRS, 1-800-877-8339. CFDA# 47.041 (Engineering Grants) CFDA# 47.075, SBE.

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